

EXPERIMENT - 3

Aim: To study the signal formation in Si detector using Transient Current Technique.

Theory:

Transient Current Technique (TCT) is one of the important methods to characterize silicon

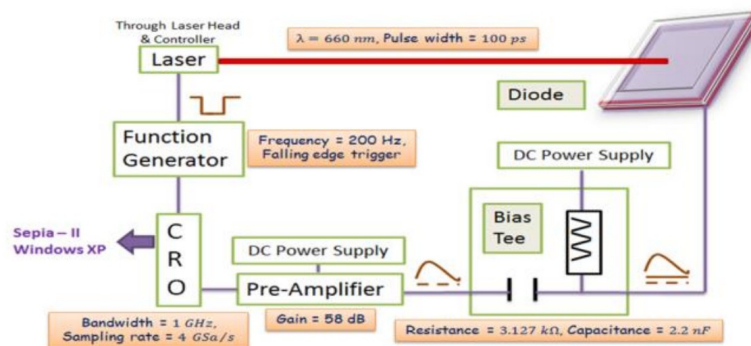
detectors and is based on the time evolution of the charge carriers generated when a laser light is shone on it. For red laser, charge is injected only to a small distance from the surface of the detector. For such a system, one of the charge carriers is collected faster than the readout time of the electronics and therefore, the effective signal at the electrodes is decided by the charge carriers that traverse throughout the active volume of the detector. So, for a detector with n-type substrate, with frontside laser illumination, the output signal is the electron signal and with rearside laser illumination, the output signal is the hole signal.

The TCT setup at Delhi University is interfaced through a developed interface software in LabView.

Apparatus:

Si pad diode detector – mounted on PCB, Electromagnetic shielded stainless steel chamber, PicoQuant red laser controller and a laser head along with optical fibre and pigtail – to illuminate the detector, Agilent E3632A function generator – to provide trigger to the laser controller, Keithley 2410 – to reverse bias the detector, Picosecond bias tee – to separate the direct and transient signals, Miteq amplifier – for amplification of the TCT signal generated, Agilent 33522A medium voltage source – to bias the amplifier, IEEE GPIB cables, BNC cables, connectors, LabView installed PC – for interfacing with the instruments via software.

Block Diagram:

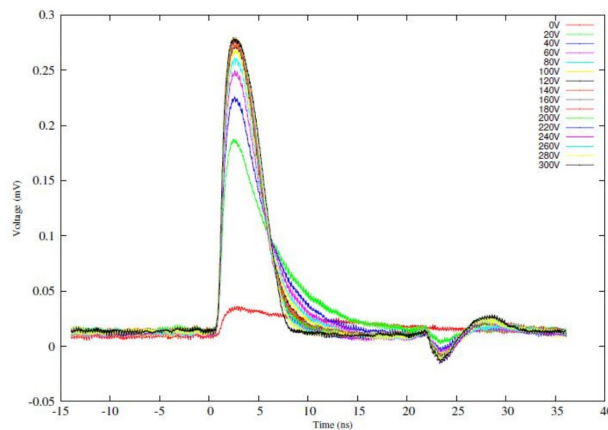


Experiment:

1. Make connections as shown in circuit diagram.
2. Set the current compliance value to 1 microamperes, and fill other information like (name of the current, name of the experimentalist, temperature, comments if any, etc.) in the LabView executable file.
3. Apply voltage from 0 to 200V (reverse bias) in steps of 10V.
4. Run the executable file t
5. Repeat the experiment.
 1. Make connections as shown in the block diagram.
 2. Set the current compliance value to 1 microamperes on K-2410 and fill other information like (name of the current, name of the experimentalist, temperature, comments if any, etc.) in the LabView executable file.
 3. Set start voltage equal to 0 and stop voltage equal to 200V (in reverse bias, depends on the polarity of the substrate), with voltage ramp step equal to 10V.
 4. Run the executable file to obtain the TCT signal.
 5. Repeat the procedure by shining the laser on the backside of the detector.
 6. Do measurements on pad diode detectors, irradiated at different fluence.

Discussion:

The red TCT signal from the electrons and the holes can provide an insight to the charge collected, the full depletion voltage, the electric field profile, the drift velocity, effective doping density, etc. of the detector substrate. Hence, the red TCT setup is a very important and useful tool in determining the change in the electrical properties of the detector with irradiation. Below is a sample plot of frontside red laser TCT signal (electron signal) for p-in-n type pad diode, at different bias voltages.



Precautions:

1. Remember to set the compliance before running the experiment.
2. Make a manual check for identification of the polarity of the detector substrate.